

Instructor Resources

Sexual Diversity in Nature Project | Module 2: Science and Identity

Created by:

Description

An organism's sex is commonly understood in society to be a binary or dichotomous and determined by genitalia or chromosomes, however in nature there is a diversity of sexes and sex determination process that have strong implications for a more inclusive society that appreciate this sexual diversity.

In this lesson, students will read articles and chapters written by biologists related to organisms' sex and sex determination process, access and communicate their prior knowledge, learn the appropriate terminology, and reflect and discuss the implications on both society and scientific communities.

Suggested Courses

Cellular Biology, Developmental Biology, Anatomy/Physiology, Genetics, Ecology, Introductory Biology

Learning Goals

- Students will know about the variety of sex determination models in nature.
- Students will value the diversity in sex and sex determination in nature.
- Students will know the appropriate terminology related to sex including the differences between gender and sex.

Learning Objectives

- Students will be able to define an organism's sex based on the organism's sex determination and differentiation.
- Students will be able to evaluate scientific writing to determine appropriate and inclusive terminology related to sex and gender.
- Students will be to define biological sex and gender.

Scientific Processing Skills:

Reading research papers, reviewing prior research

Pedagogical Approaches:

Think/Pair/Share, Reflective Writing, Discussion

Bloom's Cognitive Levels:

Foundational (factual knowledge), Application and Analysis, Evaluation

Principles of how people learn:

Focuses student on the material to be learned, reveals prior knowledge, requires student to do the bulk of the work

Vision and Change Competencies:

Apply the process of science, Interdisciplinary nature of science, Understand the relationship between science and society

Core Biological Concepts Covered:

Systems- Biological molecules, genes, cells, tissues, organs, individuals, and ecosystems interact to form complex networks. A change in one component of the network can affect many other components. And organisms have complex systems that integrate internal and external information, incorporate feedback control, and allow them to respond to changes in the environment.
Information Flow- Cells/organs/organisms have multiple mechanisms to perceive and respond to changing environmental conditions.

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Additional Resources

Diversity of Sex Content:

Videos:

- (Reedy A. 2012. Sex Determination: More Complicated Than You Thought. TedEd. YouTube) <https://www.youtube.com/watch?v=kMWxuF9YW38>
- Queer Science Presentation Video- <https://www.youtube.com/watch?v=WCcyM8FoA54&t=2088s>

Articles/Chapters:

General

- Everything You Always Wanted to Know About Sexes: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC423151/>
- Naturally clonal vertebrates are an untapped resource in ecology and evolution research: <https://www.nature.com/articles/s41559-018-0775-0>
- Evolution's Rainbow Chapter 3 'Sex within Bodies' (pg 30-42): https://teoriaevolutiva.files.wordpress.com/2013/10/joan_roughgarden_evolutions_rainbow_diversitybookos-org1.pdf
- Evolution's Rainbow Chapter 6 'Multiple-Gender Families' (pg 75- 105): https://teoriaevolutiva.files.wordpress.com/2013/10/joan_roughgarden_evolutions_rainbow_diversitybookos-org1.pdf

Organism Specific

- We use to call them hermaphrodites: <https://www.nature.com/articles/gim200711>
- Sex Change in Clownfish: Molecular Insights from Transcriptome Analysis: <https://www.nature.com/articles/srep35461>
- Caste in Social Insects: Genetic Influences Over Caste Determination: <https://www.sciencedirect.com/science/article/pii/B9780128096338207590>
- Temperature Sex Reversal Implies Sex Gene Dosage in a Reptile: <https://www.science.org/doi/10.1126/science.1135925>
- No Sex Needed: All-Female Lizard Species Cross Their Chromosomes to Make Babies: <https://www.scientificamerican.com/article/asexual-lizards/>
- Rare observation of the existence and masculine behavior of maned lionesses in the Okavango Delta, Botswana: <https://onlinelibrary.wiley.com/doi/10.1111/aje.12360>

Societal Impacts Content:

- Effects of Language on our Visual Perception: <https://files.osf.io/v1/resources/pztmc/providers/osfstorage/5ea84d2b76188b01ed9116bc?action=download&direct&version=2>
- The Gender Binary Cycle: the perpetual relations between a biological-essentialist view of gender, gender ideology, and gender-labelling and sorting: <https://royalsocietypublishing.org/doi/10.1098/rstb.2020.0141>

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Adaptations

If you want to develop modeling and communication skills and dive deeper into individual sex determination processes:

- Randomly assign students a specific organism article to read
- Have students draw a model that represents the process of how the sex is determined
- Have students combine and collaborate either in same or different article groups
- Have students evaluate one another's models and create a model as a class

Implementation Guide

	Activities	Implementation Notes
Before Class (60 min)	<ul style="list-style-type: none">• Individual KWL Chart• Article Reading with Guiding Questions	<ul style="list-style-type: none">• Optional Additional Activity: Individual Modeling
During Class (50 min)	<ul style="list-style-type: none">• Content Review and Think/Pair/Share Class KWL Chart (10 min)• Sex Determination Video (5 min)• Read: Nature's Inclusive Science: Ditch Insensitive Terminology (5 min)• Revisit Class KWL Chart (10 min)• Discussion: Implications of Biological Binary Essentialism and Terminology (10 min)• Reflection/Assessment (10 min)	<ul style="list-style-type: none">• Optional Additional Activity: Group Modeling• Reading the article in class could be done individually and quietly for 5 minutes or out loud as a class popcorn style

Student Assessment

1. Describe the activity. What was the issue you learned about?
2. What did this activity teach you about the relationship between biology and society?
3. How did the activity illustrate how human values influence science?
4. What are the different perspectives presented as part of the activity today?
5. How do your personal values or experiences relate to the themes presented in this activity, if at all? Has the activity impacted your personal values or views?
6. Did the activity make you think differently about the issue than before today's activity? How?
7. How is an organism's sex defined?
8. How is an organism's sex determined?
9. How can we change our terminology to become more inclusive and accurately reflect the diversity of sex in nature?
10. Rewrite the paragraph below to include/replace words so that it is more inclusive:
"Females have two X chromosomes and males have one X and one Y chromosome. The X and the Y are known as sex chromosomes. Genetic problems also occur when abnormalities affect the sex chromosomes. Normally, a child will be a male if he inherits one X chromosome from his mother and one Y chromosome from his father. A child will be a female if she inherits a double dose of X (one from each parent) and no Y."

Student Handout

Sexual Diversity in Nature

Name :

Date :



Introduction:

Observe the cardinal image to the left that is both male and female. In this lesson you will explore important questions relevant to biology and society: what is an organism's sex, how is their sex determined and how is sex differentiated? You will learn about the diverse representations of sex across the Kingdom Animalia and learn about the implications of our perspectives on biological sex.

Credits: Photo taken by Jamie Hill Feb 20th, 2021 in Grand Valley area of Warren County, PA

Part 1: Sexual Diversity in Nature Article

First, you will reflect on your prior knowledge of sexual diversity in nature and sex determination. Then you will read an article about an animal's sexual diversity and sex determination and consider the guiding questions while reading.

KWL Chart: Before reading your assigned animal article, fill out the K and W of the KWL chart below (leave the L blank!)

(K)	(W)	(L)
What do you already know about how sex is determined in animals?	What do you want to know about sex determination? What do you wonder ?	What have you learned about sex determination?

Student Handout

Sexual Diversity in Nature

Name :

Date :

Notes:

Article Reading: Read your assigned article and consider the following questions while reading:

- How is the sex of an organism determined?
- Based on this article, how would you define an organism's sex?

Articles:

General

- Everything You Always Wanted to Know About Sexes: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC423151/>
- Naturally clonal vertebrates are an untapped resource in ecology and evolution research: <https://www.nature.com/articles/s41559-018-0775-0>
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Organism Specific

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- Sex Change in Clownfish: Molecular Insights from Transcriptome Analysis: <https://www.nature.com/articles/srep35461>
- Caste in Social Insects: Genetic Influences Over Caste Determination: <https://www.sciencedirect.com/science/article/pii/B9780128096338207590>
- Temperature Sex Reversal Implies Sex Gene Dosage in a Reptile: <https://www.science.org/doi/10.1126/science.1135925>
- No Sex Needed: All-Female Lizard Species Cross Their Chromosomes to Make Babies: <https://www.scientificamerican.com/article/asexual-lizards/>
- Rare observation of the existence and masculine behavior of maned lionesses in the Okavango Delta, Botswana: <https://onlinelibrary.wiley.com/doi/10.1111/aje.12360>

Student Handout

Sexual Diversity in Nature

Name :

Date :

Inclusive science: ditch archaic terms

To increase inclusivity in science, we should avoid long-held descriptors for non-human organisms that could cause offence to some sectors of society. The explosion in citizen science and in science blogs ensures that the continued use of such terminology will come to the attention of people who find it hurtful.

One example is the expression 'she-male', long used to describe female mimicry by male garter snakes (R. Shine *et al. Nature* **414**, 267; 2001). Another is 'sneaky mating strategy' (see, for example, G. A. Parker *Proc. R. Soc. B* **242**, 127–133; 1990), which could be misinterpreted as endorsing conventional sex roles. And scientists continue to refer to 'dwarf' males in behavioural ecology (F. Vollrath *Trends Ecol. Evol.* **13**, 159–163; 1998), long after society in general abandoned the word as derogatory.

Language evolves, so terms applied in one situation can acquire different connotations over time. Moreover, attitudes are shaped by language, which itself can shape data interpretation (see, for example, J. D. Monk *et al. Nature Ecol. Evol.* **3**, 1622–1631; 2019).

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Part 2: Inclusive Science Terminology for Sexual Diversity

- Read the following correspondence piece from *Nature* (Vol 580, Apr 2020) to the left
- After reading your passage, watching the sex determination video, and reading the correspondence piece fill in the (L) column of your KWL chart above with what you learned.

Contribute your thoughts to discussing sex, sexual determination/differentiation, and terminology. You can record your thoughts here:

Building Continuity in Gendered Language			
Instead of...	Focus on...	Example	Why?
Men Male Women Female	the organ, functional activity, or role	<p>"Women Ovaries produce eggs."</p> <p>"Males XY individuals are more likely to be color blind."</p> <p>"The mother gestational parent carries the fetus for 9 months."</p>	<p>All people, cis & trans, experience different bodies, reproduction, and families.</p> <p>Many organisms thrive in stable families where a male-female relationship is only one of many options.</p>
Male/female hormones	testosterone, estrogen, and progesterone	<p>"People with testes produce large amounts of testosterone."</p> <p>"In an estrogen-dominant body, the bones develop like ..."</p>	<p>Testosterone and estrogen also regulate many non-sexual processes. Both hormones exist in most people of any sex with active gonads.</p>
Normal Natural Typical	patterns and probability	<p>"In many species, the female provides more parental investment than the male."</p> <p>"XX and XY are the most common combinations of sex chromosomes."</p>	<p>Living things are diverse, with no one "typical" body or behavior.</p> <p>When discussing humans, many medical & scientific statistics only use data from white, cisgender, European populations.</p>

From genderinclusivebiology.com

Student Handout

Sexual Diversity in Nature

Name :

Date :

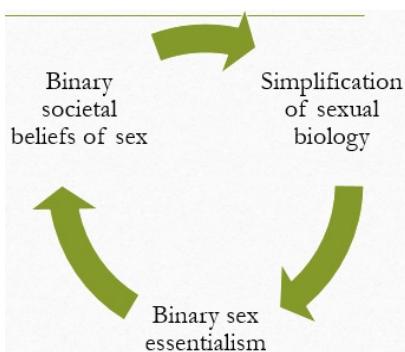
Notes:

Conclusion

In the natural world, sex isn't binary and is determined by a variety of ways (chromosomes, temperature, environment, hormones, etc.) Humans categorizing and assigning sex in nature is culturally situated by our societal values (Ex. Cisnormativity and Biological Binary Essentialism is applied to our understanding of the natural world).

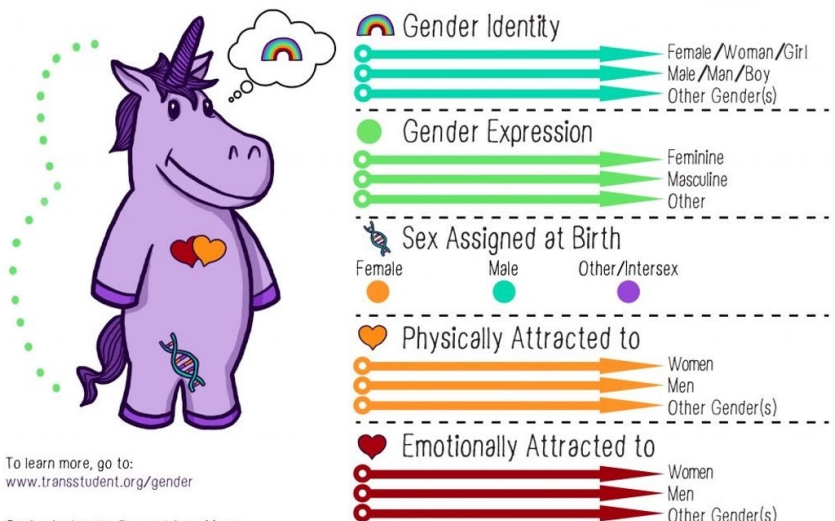
Keep the resources throughout and below to guide your own use of appropriate terminology:

- **Cisnormativity**- social norms where cis-gender identities are considered 'normal' and systems privilege cis identities.
- **Biological Binary Essentialism**- the belief that biological sex is a binary (male or female) and permanent.



The Gender Unicorn

Graphic by:
TSER
Trans Student Educational Resources



Student Assessment

Sexual Diversity in Nature

Name :

Date :

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